

THE UNIVERSITY OF NEWCASTLE

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

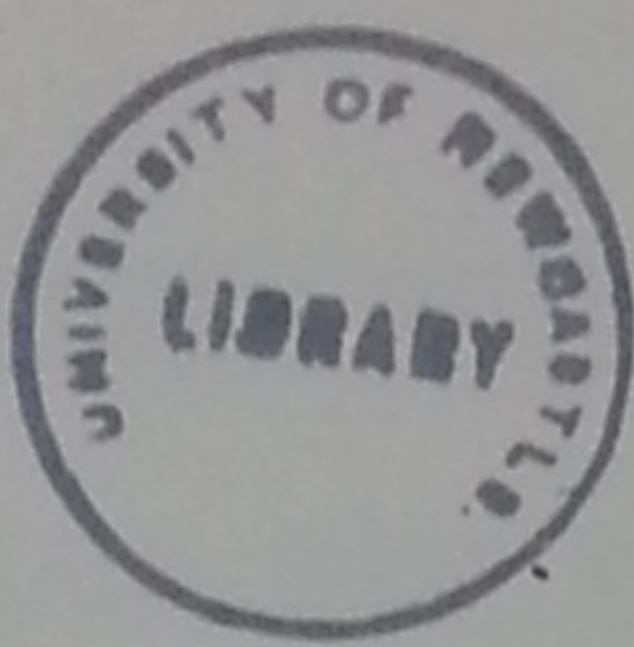
BLACK BODY RADIATION FUNCTIONS

BY

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FOR MONOCHROMATIC EMISSIVE POWER (SPECTRAL RADIANCE)
RELATIVE SPECTRAL RADIANCE TO MAXIMUM FRACTIONAL BLACK EMISSION
(RELATIVE CUMULATIVE SPECTRAL RADIANCE)
THE AUXILIARY ERROR FUNCTION

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F O R E W O R D

Research projects in this department concerned with analysis of radiation from industrial flames have frequently required figures for black-body emission both monochromatic and over wavelength bands of various widths. It rapidly became clear that some tabulations of the appropriate functions would be useful. We are indebted to Mr. Roberts, lecturer in this department, for the care with which he prepared and checked computer programs. The tables have been of such value to us that we are issuing copies of these as a Departmental Bulletin and trust that they will be of equal value to others concerned in computation of radiant transfer.

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BLACK BODY RADIATION FUNCTIONS

ABSTRACT

Four black body Planck radiation functions are discussed and tabulated over the range $250 < [n\lambda T] < 30000$ $[\mu^\circ K]$.

A comparison of some previous reference values and those determined here indicate improved accuracy and a more extensive tabulation for engineering application.

Four examples of these functions' use are outlined.

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BLACK BODY RADIATION FUNCTION

INTRODUCTION

These present Tables were developed for general use in the evaluation of many Planck type thermal radiation functions. The usual references [1, 2, 3, 4] give Planck's equations as a function of $[n\lambda T]$ for monochromatic emissive power (spectral radiance) and fractional black emission (relative cumulative spectral radiance) alone. Of these, only Harrison [2] gives a reasonably extensive tabulation with respect $[n\lambda T]$.

Four functions listed below, were evaluated and tabulated relative to $[n\lambda T]$ in the range 250 to 30000 $\mu^\circ K$ for the following range of values:-

range of $[n\lambda T]$ $\mu^\circ K$	step increment $[n\lambda T]$
250 - 500	5
500 - 4000	10
4000 - 6000	20
6000 - 10000	50
10000 - 20000	100
20000 - 30000	200

Rounding errors in the function values tabulated here are believed to not exceed 0.6 units in the seventh numeral.

FUNCTIONS TABULATED

1) Monochromatic Emissive Power (spectral radiance)

This is Planck's derived equation for the power emitted by an ideal thermal radiator, rearranged with $[n\lambda T]$ as the independent variable, where:-

$$\frac{e_{b\lambda}}{\sigma n^3 T^5} = \frac{\frac{C_1}{\sigma}}{(n\lambda T)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right)} \quad \text{units } (\mu^\circ K)^{-1}$$

The function values have been evaluated directly; all computation being carried out on an IBM 1130 Series II computer working in extended precision.

2) Ratio of Energy to Maximum Value (Relative Spectral Radiance)

For a fixed $[T]$, the Planck radiation function has a maximum dependent on $[\lambda]$. It is more convenient to use a relative value of this radiation function in the form:-

$$\frac{e_{b_{n\lambda T}}}{e_{b_{(n\lambda T)_{\max}}}} = R \text{ evaluated as a function of } (n\lambda T)$$

where

$$R = \frac{(n\lambda T)_{\max}^5 \left(e^{\frac{C_2}{(n\lambda T)_{\max}}} - 1 \right)}{(n\lambda T)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right)}$$

3) Fractional Black Emission (Relative Cumulative Spectral Radiance)

This function with $[n\lambda T]$ as the independent variable is used mainly in determining the fraction of total radiation of a black body falling within a given spectral range. Previous authors [1,2,3] have evaluated this function as a power series. Here, however, the integration necessary has been directly evaluated (see Appendix for details).

The fractional black body emission, as developed by Harrison [27], yields:-

$$\frac{e_{b_{(0 \rightarrow n\lambda T)}}}{e_{b_{(0 \rightarrow \infty)}}} = F = \frac{15}{\pi^4} \int_{\frac{C_2}{n\lambda T}}^{\infty} \frac{\left(\frac{C_2}{n\lambda T} \right)^3 d \left(\frac{C_2}{n\lambda T} \right)}{e^{\frac{C_2}{n\lambda T}} - 1}$$

It can be shown [4], that

$$F = \int_0^{n\lambda T} \frac{e_{b\lambda} d(n\lambda T)}{\sigma T^5}$$

$$= \frac{C_1}{\sigma} \int_0^{n\lambda T} \frac{d(n\lambda T)}{(n\lambda T)^5 (e^{\frac{C_2}{n\lambda T}} - 1)}$$

4) Auxiliary Error Function

Only Nagel [3] presents this important parameter necessary in the computation of Planck function derivatives. These derivatives of the blackbody radiation functions can be expressed in simple form as:-

$$\psi = \frac{\frac{C_2}{n\lambda T}}{1 - e^{-\frac{C_2}{n\lambda T}}} = \frac{x}{1 - e^{-x}} \quad \text{where } x = \frac{C_2}{n\lambda T}$$

(a) Derivatives for Spectral Radiance

$$\frac{d e_{b\lambda}}{dT} = \frac{e_{b\lambda}}{T} \cdot \psi ; \quad \frac{d e_{b\lambda}}{d\lambda} = \frac{e_{b\lambda}}{\lambda} (\psi - 5) ; \quad \frac{d e_b}{d C_2} = - \frac{e_{b\lambda}}{C_2} \cdot \psi$$

(b) Derivatives for Relative Spectral Radiance

$$\frac{d R_\lambda}{d(\lambda T)} = \frac{R_\lambda}{\lambda T} (\psi - 5) ; \quad \frac{d R_\lambda}{d\lambda} = \frac{R}{\lambda} \cdot (\psi - 5) ; \quad \frac{d R_\lambda}{dT} = \frac{R}{T} (\psi - 5) ; \quad \frac{dR}{d C_2} = \frac{R}{C_2} (5 - \psi)$$

(c) Derivatives for Fractional Black Emission

$$\frac{d F_{\lambda}}{d(\lambda T)} = \frac{e_{b\lambda}}{T \cdot e_b} = A \cdot F_{\lambda} ; \frac{d F_{\lambda}}{d\lambda} = \frac{e_{b\lambda}}{e_b} = A \cdot T \cdot F_{\lambda} ; \frac{dF_{\lambda}}{dT} = \frac{\lambda \cdot e_b}{T \cdot e_b} = A \cdot \lambda \cdot F_{\lambda}$$

$$\frac{d F_{\lambda}}{d C_2} = \frac{-\lambda e_{b\lambda}}{C_2 \cdot e_b} = -\frac{A \cdot T \cdot F_{\lambda}}{C_2}$$

$$\text{where } A = \frac{15 w_{\lambda}}{\pi^4 C_2} = 2.269135 \cdot 10^{-4} (\mu^{\circ}K)^{-1}$$

Nagel [3] evaluated this function ratio of energies as a power series expansion using Bernoulli numbers. Here, however, the function values have been computed directly.

PHYSICAL CONSTANTS

Physical constants occurring in these four equations are subject to experimental error. Because of the uncertainty in the known values of these constants, the choice of values used in the computations is, to a certain extent, arbitrary. Adopted constants for these Tables were obtained from National Bureau Standards (Oct. 1963) Bulletin [5] as follows:-

C	= velocity of light	2.997925×10^{10} cm/sec
h	= Planck's constant	6.62554×10^{-27} erg.sec
N _A	= Avagadro's Number	6.02257×10^{23} /mole
R	= Gas Constant	8.31432×10^7 erg/°K.mole

Derived constants necessary for the Planck type radiation functions are

$$C_1 = 2 \pi C^2 h \quad 3.7414735 \times 10^4 \text{ watt.cm}^{-2} \mu^4$$

$$C_2 = \frac{hC}{k} \text{ where } k = \frac{R}{N_A} \quad 14387.89 \mu \cdot ^\circ K$$

$$\sigma = \frac{\pi^4}{15} \cdot \frac{C_1}{C_2^4} \quad 5.66731 \times 10^{-12} \text{ watt.cm}^{-2} (^{\circ}K)^{-4}$$

$$\lambda_{\max} T \quad 2897.80 \mu \cdot ^\circ K$$

CHARACTERISTICS OF BLACK BODY RADIATION FUNCTIONS

a) Wavelength of Maximum Intensity

The distribution of thermal radiation emitted, as derived by Planck, is given as

$$e_{b_{n\lambda}} = \frac{C_1}{(n\lambda)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right)}$$

For radiative transfer calculations, monochromatic intensity or emissive power is most commonly used, with respect wavelength. The wavelength of maximum intensity varies in accordance with Wien's displacement law [4] is

$$\lambda_{\max} T = 2897.80 \mu \cdot ^\circ K.$$

$$\text{derived from } \lambda_{\max} \cdot T = \frac{C_2}{r_\lambda}$$

$$\text{where } r_\lambda = 4.96511423 \dots$$

b) Maximum Spectral Radiance with respect wavelength

It can be shown [4] that the maximum value of the Planck function with respect wavelength is:-

$$(e_{b\lambda})_{\max} = \frac{C_1}{C_2^5} \cdot w_\lambda \cdot T^5 \quad \text{where } w_\lambda = 21.201456 \dots$$

$$= b_1 T^5 \quad \text{where } b_1 = 1.2865373 \dots \times 10^{-15}$$

or in dimensionless form

$$\left[\frac{e_b}{\sigma n^3 T^5} \right]_{\max} = 22.691325 \times 10^5 \quad \text{at } [\lambda_{\max} \cdot T] = 2897.80 \quad \mu^\circ\text{K}$$

c) It has been formally shown by Benford [6] that 25 percent of the total radiation has a wavelength smaller than $\lambda_{\max}$.

$$\text{i.e. } \frac{e_{b(0 \rightarrow \lambda_{\max} T)}}{e_{b(0 \rightarrow \infty)}} = 0.25 \quad \text{at } [\lambda_{\max} \cdot T]$$

-
- d) For the auxiliary error function, using the value of r_λ above, Benford [6] also proved that

$$\psi = 5.0 \text{ at } [\lambda_{\max} \cdot T]$$

ABSOLUTE ACCURACY OF TABLES

These three latter [b,c,d] are guide checks on the numerical precision of computed results. Interpolation of tabulated results given in this report are in substantial agreement with these values. The following Table of computed values shows a direct comparison between previous references [2,3,4] and the current computations.

COMPARISON OF COMPUTED VALUES

$n\lambda T$ $\mu^\circ K$	Harrison (1960)	Nagel (1961)	Wiebelt (1966)	This work (1970)
1000 F	0.00032071	0.00032279	0.0003	0.0003206
e_b	0.372282	0.38276	0.374432	0.372305
2000 F	0.066725	0.066898	0.0668	0.066713
e_b	15.5012	15.874	15.5284	15.5012
3000 F	0.27322	0.27360	0.2735	0.27316
e_b	22.6269	23.139	22.6369	22.6265
4000 F	0.48085	0.48126	0.4812	0.48075
e_b	18.1600	18.560	18.1565	18.1595
5000 F	0.63372	0.63407	0.6340	0.63358
e_b	12.5917	12.864	12.5847	12.5912
6000 F	0.73778	0.73806	0.7380	0.73762
e_b	8.48584	8.6676	8.47929	8.48560
8000 F	0.85625	0.8564	0.8564	0.85606
e_b	3.99558	4.0802	3.99134	3.99537
10000 F	0.91415	0.9143	0.9142	0.91395
e_b	2.05229	2.0962	2.04983	2.05220
15000 F	0.96894	0.9690	0.9689	0.96872
e_b	0.539929	0.55109	0.539172	0.539894

with C_1	3.74126	3.7413	3.74159	$3.741735 \times 10^4 \text{ watt.cm}^{-2} \mu^4$
C_2	14388	14380	14387.9	$14387.89 \mu^\circ K$
σ	5.669	5.6819	5.6699	$5.669731 \times 10^{-12} \text{ watt.cm}^{-2} (\text{°K})^{-4}$
λT_{max}	2897.8	2896.2	2897.79	2897.80 °K

where F = fractional black emission

e_b = Monochromatic Emissive Power function.

PRACTICAL WORKING EQUATIONS

From the physical constants and coefficients used in these computations, the following practical equations may be obtained:-

$$e_{b_{n\lambda_{\max}}} = e_{b_{n\lambda_{\max},T}} = b_1 T^5 \text{ watt.cm}^{-2}$$

$$\text{where } b_1 = 1.286537... \times 10^{-15} \text{ watts cm}^{-2} \cdot \mu. (\text{°K})^{-5}$$

$$\frac{e_{b_{n\lambda T}}}{e_{b_{(n\lambda T)_{\max}}}} = \frac{2.9081744... \times 10^{15}}{(n\lambda T)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right)} = R_{\text{Tabulated}}$$

$$\text{then } e_{b_{n\lambda}} = b_1 \cdot R \cdot (nT)^5 \text{ watt cm}^{-2}$$

$$\frac{e_{b_{(0 \rightarrow n\lambda T)}}}{e_{b_{(0 \rightarrow \infty)}}} = F_{\text{Tabulated}} \quad \text{where } e_{b_{(0 \rightarrow \infty)}} = \sigma n^2 T^4$$

$$\text{and } \sigma = 5.669731... \times 10^{-12} \text{ watt.cm}^{-2} (\text{°K})^{-4}$$

$$\text{then } e_{b_{(0 \rightarrow n\lambda T)}} = F \sigma \cdot T^4 \text{ watt. cm}^{-2}$$

$$\text{and } e_{b_{(n\lambda T_1 \rightarrow n\lambda T_2)}} = (F_2 - F_1) \cdot \sigma T^4 \text{ watt.cm}^{-2}$$

EXAMPLES IN PRACTICAL APPLICATION OF TABLES

1) Energy of a Narrow Spectral Band into a Radiometer

Problem: To determine the amount of energy in watts at wavelength $\lambda = 0.500\mu$ emitted in a spectral band of width $\Delta\lambda = 0.002\mu$ by a surface $A_1 = 4 \text{ cm}^2$ with emissivity $\epsilon = 0.500$ and temperature $T = 2000^\circ\text{K}$. radiating perpendicularly into the front aperture of area $A_2 = 50 \text{ cm}^2$ of a radiometer located a distance $d = 100 \text{ m}$ from the radiating surface.

Solution
$$E = \epsilon N_{\lambda}(\lambda.T) \cdot A_1 \cdot \frac{A_2 \Omega_o}{d^2}$$

where $\Omega_o = \text{steradian}$

$$\epsilon = 0.5$$

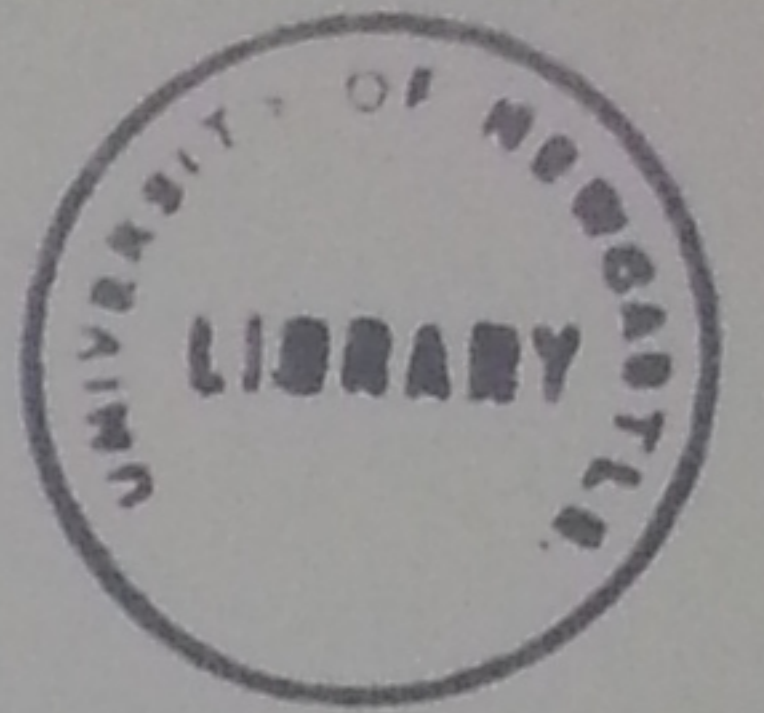
$$\frac{A_1 A_2 \Omega_o}{d^2} = 2. \times 10^{-6} \text{ cm}^2 \text{ steradian}$$

$$\Delta\lambda = 2. \times 10^{-7} \text{ cm}$$

$$(\lambda.T) = 1000\mu .^\circ\text{K} \text{ then } R = 0.01640738 \text{ from Table}$$

$$\begin{aligned} N_{\lambda}(\lambda.T) &= \frac{e_{b_{n\lambda}}(T)}{\pi} = \frac{b_1 R.T^5}{\pi} \\ &= \frac{1.286537 \times 10^{-15}}{\pi} \times 0.01640738 \times (2000)^5 \\ &= 1.286537 \times 1.640738 \times \frac{3.2}{\pi} \times 10^{-1} \text{ watt. cm}^{-2} \\ &= 2.15012 \times 10^{-1} \text{ watt. cm}^{-2} . \text{ster}^{-1} \end{aligned}$$

$$\begin{aligned} E &= 2.15012 \times 10^{-1} \times 0.5 \times 4 \times 10^{-13} \\ &= 4.3002 \times 10^{-14} \text{ watts} \end{aligned}$$



2) Radiance for Wide Spectral Band

Problem: To determine the partial radiance in watt. $\text{cm}^{-2} \cdot \text{ster}^{-1}$ of an ideal black body at 1820°K due, alone, to radiation emitted in the wavelength band $\lambda_1 = 0.610$ to $\lambda_2 = 1.30\mu$.

Solution

$$E = N_{\lambda(\lambda T)}_{1-2}$$

$$\lambda_1 T = 1110.2 \mu^\circ\text{K} \quad \text{then} \quad F_1 = 0.0009996 \text{ from Table}$$

$$\lambda_2 T = 2056.6 \mu^\circ\text{K} \quad F_2 = 0.0757474$$

$$\begin{aligned} e_{b(1-2)} &= (F_2 - F_1) \sigma \cdot T^4 \\ &= 0.0747478 \times 5.669731 \times 10^{-12} \times 1820^4 \\ &= 4.2380 \times 10^{-13} \times 10.9720 \times 10^{12} \\ &= 4.64993 \end{aligned}$$

$$\begin{aligned} E &= \frac{e_{b(1-2)}}{\pi} \\ &= 1.4801 \text{ watt. cm}^{-2} \cdot \text{ster}^{-1} \end{aligned}$$

- 3) Problem: Determine the fraction of energy a black body emits at 1500°K between the wavelengths 2 to 4μ.

Solution:

$$\text{Fraction} = F_2 - F_1$$

$$\lambda_1 T = 3000 \mu \cdot ^\circ K \quad \text{then } F_1 = 0.2731630 \text{ from Table}$$

$$\lambda_2 T = 6000 \mu \cdot ^\circ K \quad F_2 = 0.7376216$$

$$e_\lambda \text{ Fraction} = 0.46446$$

- 4) Problem: Determine the percent change $\frac{de_b}{e_b}$ for a spectral radiance of a black body at temperature $T = 1610^\circ K$ at a wavelength $\lambda = 0.520 \mu$ if C_2 is changed from 1.438 cm K to 1.435 cm °K. because of conflict between chosen value of C_2 and that published.

Solution:

$$\frac{de_b}{e_b} = -\psi \frac{dC_2}{C_2}$$

where $T = 837.2 \mu \cdot ^\circ K$ then $\psi = 17.186$ from Table

$$\frac{dC_2}{C_2} = \frac{1.435 - 1.438}{1.438} = -0.0020862$$

$$\therefore \frac{de_b}{e_b} = + 0.03585 \equiv + 3.585\%$$

NOMENCLATURE

A	coefficient used in Fractional Black Emission derivatives	$A = \frac{15 w_{\lambda}}{\pi^4 c_2}$
b_1	coefficient used in maximum spectral radiance equation, watt/cm ² μ ⁶ °K ⁵ (μ°K) ⁻¹	
C_1	Planck's first radiation constant	watt μ ⁴ /cm ²
C_2	Planck's second radiation constant	μ.°K
e_b	monochromatic emissive power of a blackbody	watt/cm ²
F	fractional black body emission	-
n	refractive index of medium	-
r_{λ}	transcendental constant in Wien's displacement law	-
R	Ratio of energy to the maximum value	-
w_{λ}	transcendental constant in maximum spectral radiance	-
x	Auxiliary error function parameter	-
σ	Stefan-Boltzmann constant	watt/cm ² °K ⁻⁴
λ	wavelength	
ψ	Auxiliary error function	-

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APPENDIX

Integration Procedure

$$\frac{e_{b(0 \rightarrow n\lambda T)}}{e_{b(0 \rightarrow \infty)}} = F = \frac{C_1}{\sigma} \int_0^{n\lambda T} \frac{d(n\lambda T)}{(n\lambda T)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right)}$$

The actual integration of this function followed the standard Simpson Rule numerical integration technique with automatic interval halving, together with deferred approach to the limit [7]. Halving proceeded until the compared difference between previous and current integration value was similar in magnitude to the inherent error generation of the computer after N steps.

A real limiting value of $[n\lambda T]$ and thus $\left(\frac{C_2}{n\lambda T} \right)$ was necessary because of the operational magnitude of the IBM 1130 Series II computer. Arithmetic computation was allowed between the limits of 10^{-39} to 10^{38} for this computer which meant that:-

$$(n\lambda T)^5 \left(e^{\frac{C_2}{n\lambda T}} - 1 \right) < 10^{38}$$

for which $n\lambda T > 236 \mu.^{\circ}K$

The actual lower limit used in computation was $240 \mu.^{\circ}K$.

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
250	0.684628E-16	0.301714E-17	0.2812495E-20	57.554
255	0.191663E-15	0.844655E-17	0.8815938E-20	56.426
260	0.514764E-15	0.226855E-16	0.2521813E-19	55.340
265	0.132953E-14	0.585921E-16	0.6827601E-19	54.296
270	0.330954E-14	0.145850E-15	0.1771272E-18	53.291
275	0.795615E-14	0.350625E-15	0.4426815E-18	52.322
280	0.185066E-13	0.815584E-15	0.1069087E-17	51.387
285	0.417262E-13	0.183886E-14	0.2500366E-17	50.486
290	0.913394E-13	0.402530E-14	0.5673504E-17	49.615
295	0.194419E-12	0.856799E-14	0.1250992E-16	48.775
300	0.402967E-12	0.177586E-13	0.2684429E-16	47.962
305	0.814384E-12	0.358896E-13	0.5613493E-16	47.175
310	0.160678E-11	0.708106E-13	0.1145377E-15	46.414
315	0.309857E-11	0.136553E-12	0.2283036E-15	45.678
320	0.584674E-11	0.257664E-12	0.4450476E-15	44.964
325	0.108058E-10	0.476211E-12	0.8493372E-15	44.272
330	0.195801E-10	0.862891E-12	0.1588400E-14	43.601
335	0.348156E-10	0.153431E-11	0.2913689E-14	42.951
340	0.608002E-10	0.267945E-11	0.5246924E-14	42.319
345	0.104365E-09	0.459933E-11	0.9283196E-14	41.706
350	0.176218E-09	0.776588E-11	0.1614931E-13	41.110
355	0.292887E-09	0.129074E-10	0.2764318E-13	40.531
360	0.479509E-09	0.211318E-10	0.4659035E-13	39.968
365	0.773775E-09	0.341000E-10	0.7736734E-13	39.420
370	0.123144E-08	0.542693E-10	0.1266595E-12	38.888
375	0.193392E-08	0.852277E-10	0.2045440E-12	38.369
380	0.299866E-08	0.132150E-09	0.3260183E-12	37.864
385	0.459298E-08	0.202411E-09	0.5131308E-12	37.373
390	0.695270E-08	0.306403E-09	0.7979183E-12	36.893
395	0.104064E-07	0.458608E-09	0.1226408E-11	36.426
400	0.154073E-07	0.678996E-09	0.1864020E-11	35.971
405	0.225740E-07	0.994831E-09	0.2802769E-11	35.527
410	0.327430E-07	0.144297E-08	0.4170796E-11	35.094
415	0.470346E-07	0.207280E-08	0.6144840E-11	34.671
420	0.669359E-07	0.294984E-08	0.8966432E-11	34.258
425	0.944042E-07	0.416036E-08	0.1296271E-10	33.855
430	0.131993E-06	0.581693E-08	0.1857300E-10	33.461
435	0.183011E-06	0.806528E-08	0.2638241E-10	33.077
440	0.251707E-06	0.110926E-07	0.3716405E-10	32.701
445	0.343498E-06	0.151378E-07	0.5193162E-10	32.334
450	0.465244E-06	0.205032E-07	0.7200446E-10	31.974
455	0.625572E-06	0.275688E-07	0.9908750E-10	31.623
460	0.835254E-06	0.368094E-07	0.1353688E-09	31.279
465	0.110765E-05	0.488142E-07	0.1836379E-09	30.943
470	0.145927E-05	0.643098E-07	0.2474281E-09	30.614
475	0.191031E-05	0.841869E-07	0.3311873E-09	30.291
480	0.248540E-05	0.109530E-06	0.4404812E-09	29.976
485	0.321439E-05	0.141657E-06	0.5822335E-09	29.667
490	0.413326E-05	0.182151E-06	0.7650094E-09	29.364
495	0.528515E-05	0.232915E-06	0.9993467E-09	29.067

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
500	0.672152E-05	0.296215E-06	0.1298142E-08	28.777
510	0.107030E-04	0.471682E-06	0.2155253E-08	28.213
520	0.167094E-04	0.736378E-06	0.3505507E-08	27.670
530	0.256050E-04	0.112840E-05	0.5592353E-08	27.148
540	0.385535E-04	0.169904E-05	0.8760027E-08	26.645
550	0.570965E-04	0.251622E-05	0.1348728E-07	26.161
560	0.832452E-04	0.366859E-05	0.2042964E-07	25.693
570	0.119586E-03	0.527014E-05	0.3047155E-07	25.243
580	0.169404E-03	0.746559E-05	0.4478986E-07	24.807
590	0.236812E-03	0.104362E-04	0.6493004E-07	24.387
600	0.326905E-03	0.144066E-04	0.9289659E-07	23.981
610	0.445918E-03	0.196514E-04	0.1312589E-06	23.587
620	0.601402E-03	0.265036E-04	0.1832742E-06	23.207
630	0.802406E-03	0.353618E-04	0.2530278E-06	22.839
640	0.105967E-02	0.466995E-04	0.3455929E-06	22.482
650	0.138583E-02	0.610733E-04	0.4672093E-06	22.136
660	0.179561E-02	0.791322E-04	0.6254843E-06	21.800
670	0.230603E-02	0.101626E-03	0.8296059E-06	21.475
680	0.293660E-02	0.129415E-03	0.1090591E-05	21.159
690	0.370953E-02	0.163478E-03	0.1421539E-05	20.853
700	0.464991E-02	0.204920E-03	0.1837912E-05	20.555
710	0.578588E-02	0.254982E-03	0.2357833E-05	20.265
720	0.714879E-02	0.315045E-03	0.3002394E-05	19.984
730	0.877335E-02	0.386639E-03	0.3795992E-05	19.710
740	0.106977E-01	0.471447E-03	0.4766667E-05	19.444
750	0.129637E-01	0.571310E-03	0.5946455E-05	19.184
760	0.156169E-01	0.688232E-03	0.7371751E-05	18.932
770	0.187062E-01	0.824377E-03	0.9083679E-05	18.686
780	0.222846E-01	0.982077E-03	0.1112846E-04	18.446
790	0.264087E-01	0.116382E-02	0.1355780E-04	18.213
800	0.311389E-01	0.137228E-02	0.1642924E-04	17.985
810	0.365390E-01	0.161026E-02	0.1980654E-04	17.763
820	0.426766E-01	0.188074E-02	0.2376001E-04	17.547
830	0.496224E-01	0.218684E-02	0.2836691E-04	17.335
840	0.574508E-01	0.253184E-02	0.3371173E-04	17.129
850	0.662389E-01	0.291913E-02	0.3988653E-04	16.927
860	0.760669E-01	0.335224E-02	0.4699124E-04	16.730
870	0.870175E-01	0.383483E-02	0.5513396E-04	16.538
880	0.991759E-01	0.437065E-02	0.6443115E-04	16.350
890	0.112629E 00	0.496355E-02	0.7500792E-04	16.167
900	0.127467E 00	0.561745E-02	0.8699821E-04	15.987
910	0.143780E 00	0.633637E-02	0.1005449E-03	15.811
920	0.161660E 00	0.712435E-02	0.1158002E-03	15.639
930	0.181201E 00	0.798548E-02	0.1329253E-03	15.471
940	0.202494E 00	0.892389E-02	0.1520908E-03	15.307
950	0.225635E 00	0.994371E-02	0.1734768E-03	15.145
960	0.250717E 00	0.110490E-01	0.1972727E-03	14.988
970	0.277833E 00	0.122440E-01	0.2236771E-03	14.833
980	0.307076E 00	0.135327E-01	0.2528981E-03	14.682
990	0.338537E 00	0.149192E-01	0.2851528E-03	14.533

NLMBDAT MICRON	DEG.K	MONOCHROMATIC EMISSIVE POWER $\times 10^5$	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
1000		0.372305	0.01640738	0.0003206	14.388
1010		0.408469	0.01800113	0.0003596	14.246
1020		0.447115	0.01970424	0.0004024	14.106
1030		0.488326	0.02152043	0.0004491	13.969
1040		0.532185	0.02345324	0.0005001	13.835
1050		0.578767	0.02550613	0.0005556	13.703
1060		0.628150	0.02768239	0.0006159	13.574
1070		0.680403	0.02998517	0.0006813	13.447
1080		0.735595	0.03241746	0.0007521	13.322
1090		0.793789	0.03498206	0.0008285	13.200
1100		0.855045	0.03768161	0.0009109	13.080
1110		0.919419	0.04051856	0.0009996	12.962
1120		0.986962	0.04349517	0.0010949	12.847
1130		1.057721	0.04661348	0.0011970	12.733
1140		1.131737	0.04987535	0.0013065	12.621
1150		1.209048	0.05328242	0.0014234	12.511
1160		1.289686	0.05683610	0.0015483	12.404
1170		1.373678	0.06053762	0.0016814	12.298
1180		1.461048	0.06438797	0.0018231	12.193
1190		1.551812	0.06838793	0.0019737	12.091
1200		1.645984	0.07253805	0.0021335	11.990
1210		1.743570	0.07683867	0.0023029	11.891
1220		1.844575	0.08128991	0.0024823	11.794
1230		1.948995	0.08589169	0.0026719	11.698
1240		2.056824	0.09064369	0.0028721	11.603
1250		2.168051	0.09554539	0.0030833	11.511
1260		2.282657	0.10059607	0.0033057	11.419
1270		2.400623	0.10579480	0.0035398	11.329
1280		2.521923	0.11114046	0.0037859	11.241
1290		2.646527	0.11663172	0.0040442	11.154
1300		2.774401	0.12226707	0.0043151	11.068
1310		2.905505	0.12804481	0.0045991	10.983
1320		3.039799	0.13396308	0.0048962	10.900
1330		3.177234	0.14001983	0.0052070	10.818
1340		3.317762	0.14621285	0.0055316	10.738
1350		3.461329	0.15253978	0.0058705	10.658
1360		3.607876	0.15899809	0.0062238	10.580
1370		3.757345	0.16558513	0.0065920	10.502
1380		3.909671	0.17229809	0.0069752	10.426
1390		4.064788	0.17913405	0.0073739	10.351
1400		4.222626	0.18608994	0.0077881	10.277
1410		4.383114	0.19316260	0.0082183	10.205
1420		4.546177	0.20034876	0.0086646	10.133
1430		4.711740	0.20764504	0.0091274	10.062
1440		4.879722	0.21504796	0.0096068	9.992
1450		5.050043	0.22255398	0.0101032	9.923
1460		5.222621	0.23015944	0.0106167	9.855
1470		5.397372	0.23786066	0.0111476	9.788
1480		5.574210	0.24565384	0.0116960	9.722
1490		5.753047	0.25353517	0.0122622	9.657

NLAMB DAT MICRON	MONOCHROMATIC DEG.K EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
1500	5.933797	0.26150077	0.0128464	9.593
1510	6.116370	0.26954671	0.0134488	9.529
1520	6.300676	0.27766903	0.0140695	9.466
1530	6.486625	0.28586373	0.0147087	9.405
1540	6.674125	0.29412680	0.0153666	9.344
1550	6.863085	0.30245420	0.0160433	9.283
1560	7.053412	0.31084189	0.0167389	9.224
1570	7.245016	0.31928581	0.0174537	9.165
1580	7.437803	0.32778189	0.0181877	9.107
1590	7.631682	0.33632609	0.0189410	9.050
1600	7.826561	0.34491435	0.0197137	8.994
1610	8.022349	0.35354265	0.0205060	8.938
1620	8.218954	0.36220697	0.0213178	8.883
1630	8.416286	0.37090333	0.0221494	8.828
1640	8.614254	0.37962775	0.0230007	8.774
1650	8.812770	0.38837630	0.0238719	8.721
1660	9.011746	0.39714509	0.0247629	8.669
1670	9.211093	0.40593025	0.0256739	8.617
1680	9.410724	0.41472796	0.0266047	8.566
1690	9.610556	0.42353447	0.0275556	8.515
1700	9.810502	0.43234604	0.0285264	8.465
1710	10.010479	0.44115899	0.0295173	8.416
1720	10.210406	0.44996972	0.0305281	8.367
1730	10.410202	0.45877465	0.0315589	8.319
1740	10.609787	0.46757030	0.0326097	8.271
1750	10.809083	0.47635321	0.0336804	8.224
1760	11.008013	0.48512001	0.0347710	8.177
1770	11.206502	0.49386738	0.0358815	8.131
1780	11.404477	0.50259207	0.0370118	8.086
1790	11.601865	0.51129092	0.0381618	8.040
1800	11.798596	0.51996079	0.0393316	7.996
1810	11.994601	0.52859867	0.0405210	7.952
1820	12.189812	0.53720158	0.0417300	7.908
1830	12.384165	0.54576662	0.0429584	7.865
1840	12.577593	0.55429098	0.0442062	7.823
1850	12.770037	0.56277190	0.0454733	7.780
1860	12.961434	0.57120671	0.0467596	7.739
1870	13.151726	0.57959282	0.0480650	7.697
1880	13.340855	0.58792770	0.0493894	7.657
1890	13.528766	0.59620889	0.0507325	7.616
1900	13.715406	0.60443404	0.0520945	7.576
1910	13.900721	0.61260084	0.0534750	7.537
1920	14.084662	0.62070707	0.0548739	7.498
1930	14.267180	0.62875059	0.0562912	7.459
1940	14.448228	0.63672932	0.0577267	7.421
1950	14.627761	0.64464126	0.0591802	7.383
1960	14.805734	0.65248449	0.0606516	7.345
1970	14.982106	0.66025716	0.0621406	7.308
1980	15.156837	0.66795750	0.0636473	7.272
1990	15.329888	0.67558381	0.0651713	7.235

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER $\times 10^5$	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
2000	15.501222	0.68313444	0.0667125	7.199
2010	15.670803	0.69060783	0.0682708	7.164
2020	15.838598	0.69800251	0.0698459	7.128
2030	16.004574	0.70531703	0.0714377	7.093
2040	16.168701	0.71255006	0.0730460	7.059
2050	16.330949	0.71970029	0.0746707	7.025
2060	16.491291	0.72676652	0.0763115	6.991
2070	16.649701	0.73374759	0.0779682	6.957
2080	16.806153	0.74064241	0.0796406	6.924
2090	16.960625	0.74744995	0.0813286	6.891
2100	17.113095	0.75416926	0.0830319	6.858
2110	17.263542	0.76079941	0.0847504	6.826
2120	17.411947	0.76733958	0.0864838	6.794
2130	17.558293	0.77378898	0.0882319	6.763
2140	17.702562	0.78014688	0.0899946	6.731
2150	17.844740	0.78641262	0.0917716	6.700
2160	17.984812	0.79258558	0.0935627	6.669
2170	18.122767	0.79866520	0.0953677	6.639
2180	18.258592	0.80465098	0.0971864	6.609
2190	18.392277	0.81054245	0.0990185	6.579
2200	18.523814	0.81633922	0.1008639	6.549
2210	18.653193	0.82204093	0.1027224	6.520
2220	18.780409	0.82764728	0.1045937	6.491
2230	18.905454	0.83315800	0.1064776	6.462
2240	19.028325	0.83857288	0.1083738	6.433
2250	19.149017	0.84389176	0.1102823	6.405
2260	19.267528	0.84911450	0.1122027	6.377
2270	19.383856	0.85424103	0.1141349	6.349
2280	19.497999	0.85927130	0.1160786	6.322
2290	19.609959	0.86420531	0.1180335	6.295
2300	19.719735	0.86904310	0.1199996	6.267
2310	19.827329	0.87378474	0.1219765	6.241
2320	19.932743	0.87843034	0.1239641	6.214
2330	20.035982	0.88298005	0.1259621	6.188
2340	20.137049	0.88743404	0.1279704	6.162
2350	20.235949	0.89179253	0.1299886	6.136
2360	20.332687	0.89605577	0.1320166	6.110
2370	20.427271	0.90022402	0.1340542	6.085
2380	20.519706	0.90429760	0.1361011	6.060
2390	20.610000	0.90827684	0.1381571	6.035
2400	20.698162	0.91216211	0.1402221	6.010
2410	20.784200	0.91595378	0.1422958	5.985
2420	20.868124	0.91965229	0.1443779	5.961
2430	20.949943	0.92325805	0.1464684	5.937
2440	21.029669	0.92677156	0.1485669	5.913
2450	21.107313	0.93019327	0.1506733	5.889
2460	21.182885	0.93352372	0.1527874	5.865
2470	21.256397	0.93676340	0.1549089	5.842
2480	21.327864	0.93991291	0.1570377	5.819
2490	21.397296	0.94297278	0.1591735	5.796

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
2500	21.464708	0.94594360	0.1613161	5.773
2510	21.530114	0.94882600	0.1634654	5.751
2520	21.593527	0.95162059	0.1656211	5.728
2530	21.654961	0.95432799	0.1677831	5.706
2540	21.714433	0.95694888	0.1699511	5.684
2550	21.771956	0.95948391	0.1721249	5.662
2560	21.827546	0.96193377	0.1743044	5.641
2570	21.881220	0.96429915	0.1764894	5.619
2580	21.932992	0.96658075	0.1786796	5.598
2590	21.982880	0.96877930	0.1808750	5.577
2600	22.030900	0.97089552	0.1830752	5.556
2610	22.077069	0.97293016	0.1852801	5.535
2620	22.121403	0.97488396	0.1874896	5.514
2630	22.163920	0.97675767	0.1897033	5.494
2640	22.204637	0.97855207	0.1919213	5.473
2650	22.243573	0.98026793	0.1941432	5.453
2660	22.280743	0.98190603	0.1963690	5.433
2670	22.316167	0.98346715	0.1985983	5.413
2680	22.349863	0.98495210	0.2008312	5.394
2690	22.381847	0.98636166	0.2030673	5.374
2700	22.412140	0.98769665	0.2053065	5.355
2710	22.440759	0.98895787	0.2075486	5.335
2720	22.467722	0.99014613	0.2097936	5.316
2730	22.493049	0.99126226	0.2120411	5.297
2740	22.516757	0.99230707	0.2142911	5.278
2750	22.538865	0.99328138	0.2165434	5.260
2760	22.559392	0.99418601	0.2187979	5.241
2770	22.578357	0.99502181	0.2210543	5.223
2780	22.595779	0.99578958	0.2233125	5.205
2790	22.611677	0.99649017	0.2255724	5.187
2800	22.626068	0.99712438	0.2278338	5.169
2810	22.638972	0.99769307	0.2300965	5.151
2820	22.650408	0.99819706	0.2323605	5.133
2830	22.660395	0.99863717	0.2346256	5.116
2840	22.668951	0.99901424	0.2368915	5.098
2850	22.676096	0.99932910	0.2391583	5.081
2860	22.681847	0.99958257	0.2414257	5.064
2870	22.686224	0.99977547	0.2436936	5.047
2880	22.689246	0.99990862	0.2459619	5.030
2890	22.690931	0.99998287	0.2482304	5.013
2900	22.691297	0.99999900	0.2504990	4.996
2910	22.690363	0.99995785	0.2527676	4.980
2920	22.688148	0.99986022	0.2550361	4.963
2930	22.684669	0.99970693	0.2573042	4.947
2940	22.679946	0.99949879	0.2595719	4.931
2950	22.673996	0.99923658	0.2618392	4.914
2960	22.666838	0.99892113	0.2641057	4.898
2970	22.658490	0.99855321	0.2663715	4.883
2980	22.648969	0.99813362	0.2686364	4.867
2990	22.638293	0.99766314	0.2709002	4.851

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
3000	22.626481	0.99714257	0.2731630	4.836
3010	22.613549	0.99657268	0.2754245	4.820
3020	22.599516	0.99595424	0.2776846	4.805
3030	22.584398	0.99528802	0.2799434	4.790
3040	22.568214	0.99457478	0.2822005	4.775
3050	22.550980	0.99381527	0.2844560	4.760
3060	22.532713	0.99301027	0.2867097	4.745
3070	22.513431	0.99216050	0.2889615	4.730
3080	22.493150	0.99126671	0.2912113	4.715
3090	22.471886	0.99032964	0.2934591	4.701
3100	22.449657	0.98935002	0.2957047	4.686
3110	22.426479	0.98832858	0.2979480	4.672
3120	22.402369	0.98726603	0.3001889	4.658
3130	22.377341	0.98616308	0.3024274	4.643
3140	22.351413	0.98502044	0.3046634	4.629
3150	22.324601	0.98383882	0.3068967	4.615
3160	22.296919	0.98261890	0.3091273	4.601
3170	22.268384	0.98136138	0.3113551	4.588
3180	22.239012	0.98006693	0.3135799	4.574
3190	22.208817	0.97873624	0.3158018	4.560
3200	22.177814	0.97736997	0.3180207	4.547
3210	22.146019	0.97596879	0.3202364	4.533
3220	22.113447	0.97453334	0.3224489	4.520
3230	22.080113	0.97306429	0.3246581	4.507
3240	22.046030	0.97156227	0.3268639	4.493
3250	22.011213	0.97002793	0.3290663	4.480
3260	21.975678	0.96846189	0.3312652	4.467
3270	21.939437	0.96686477	0.3334604	4.454
3280	21.902505	0.96523720	0.3356520	4.442
3290	21.864896	0.96357978	0.3378399	4.429
3300	21.826624	0.96189311	0.3400240	4.416
3310	21.787701	0.96017780	0.3422043	4.404
3320	21.748142	0.95843444	0.3443806	4.391
3330	21.707959	0.95666361	0.3465529	4.379
3340	21.667167	0.95486588	0.3487212	4.366
3350	21.625777	0.95304184	0.3508854	4.354
3360	21.583802	0.95119203	0.3530454	4.342
3370	21.541256	0.94931703	0.3552012	4.330
3380	21.498150	0.94741737	0.3573527	4.318
3390	21.454497	0.94549361	0.3594998	4.306
3400	21.410310	0.94354629	0.3616426	4.294
3410	21.365600	0.94157593	0.3637809	4.282
3420	21.320379	0.93958306	0.3659147	4.270
3430	21.274659	0.93756820	0.3680440	4.259
3440	21.228452	0.93553186	0.3701687	4.247
3450	21.181769	0.93347454	0.3722888	4.236
3460	21.134621	0.93139676	0.3744041	4.224
3470	21.087020	0.92929899	0.3765147	4.213
3480	21.038976	0.92718172	0.3786206	4.201
3490	20.990501	0.92504544	0.3807216	4.190

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
3500	20.941606	0.92289062	0.3828177	4.179
3510	20.892300	0.92071773	0.3849090	4.168
3520	20.842595	0.91852723	0.3869952	4.157
3530	20.792500	0.91631957	0.3890765	4.146
3540	20.742026	0.91409520	0.3911528	4.135
3550	20.691183	0.91185457	0.3932240	4.124
3560	20.639981	0.90959811	0.3952901	4.114
3570	20.588430	0.90732626	0.3973511	4.103
3580	20.536539	0.90503944	0.3994069	4.092
3590	20.484318	0.90273806	0.4014575	4.082
3600	20.431775	0.90042255	0.4035028	4.071
3610	20.378922	0.89809331	0.4055429	4.061
3620	20.325766	0.89575074	0.4075777	4.050
3630	20.272317	0.89339524	0.4096072	4.040
3640	20.218583	0.89102720	0.4116313	4.030
3650	20.164573	0.88864700	0.4136500	4.020
3660	20.110296	0.88625503	0.4156633	4.010
3670	20.055760	0.88385164	0.4176711	3.999
3680	20.000974	0.88143723	0.4196735	3.989
3690	19.945945	0.87901214	0.4216704	3.979
3700	19.890683	0.87657674	0.4236618	3.970
3710	19.835194	0.87413137	0.4256477	3.960
3720	19.779487	0.87167638	0.4276280	3.950
3730	19.723570	0.86921213	0.4296027	3.940
3740	19.667450	0.86673892	0.4315718	3.931
3750	19.611134	0.86425712	0.4335353	3.921
3760	19.554631	0.86176703	0.4354932	3.911
3770	19.497947	0.85926897	0.4374454	3.902
3780	19.441089	0.85676328	0.4393919	3.893
3790	19.384065	0.85425025	0.4413327	3.883
3800	19.326882	0.85173019	0.4432678	3.874
3810	19.269546	0.84920341	0.4451972	3.865
3820	19.212064	0.84667019	0.4471209	3.855
3830	19.154442	0.84413083	0.4490388	3.846
3840	19.096688	0.84158563	0.4509509	3.837
3850	19.038808	0.83903485	0.4528573	3.828
3860	18.980807	0.83647879	0.4547578	3.819
3870	18.922693	0.83391771	0.4566526	3.810
3880	18.864471	0.83135187	0.4585415	3.801
3890	18.806147	0.82878156	0.4604246	3.792
3900	18.747727	0.82620702	0.4623019	3.783
3910	18.689217	0.82362851	0.4641734	3.775
3920	18.630623	0.82104628	0.4660389	3.766
3930	18.571950	0.81846059	0.4678986	3.757
3940	18.513204	0.81587167	0.4697525	3.749
3950	18.454391	0.81327976	0.4716005	3.740
3960	18.395514	0.81068509	0.4734426	3.732
3970	18.336581	0.80808791	0.4752788	3.723
3980	18.277595	0.80548843	0.4771091	3.715
3990	18.218562	0.80288688	0.4789335	3.706

NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
4000	18.159488	0.80028347	0.4807520	3.698
4020	18.041232	0.79507196	0.4843712	3.681
4040	17.922865	0.78985556	0.4879668	3.665
4060	17.804424	0.78463590	0.4915388	3.649
4080	17.685944	0.77941454	0.4950870	3.633
4100	17.567460	0.77419298	0.4986116	3.617
4120	17.449004	0.76897266	0.5021125	3.602
4140	17.330608	0.76375499	0.5055897	3.586
4160	17.212303	0.75854130	0.5090432	3.571
4180	17.094117	0.75333289	0.5124731	3.556
4200	16.976079	0.74813101	0.5158793	3.541
4220	16.858217	0.74293684	0.5192620	3.526
4240	16.740556	0.73775153	0.5226211	3.511
4260	16.623120	0.73257620	0.5259568	3.496
4280	16.505936	0.72741190	0.5292689	3.482
4300	16.389024	0.72225965	0.5325577	3.468
4320	16.272408	0.71712042	0.5358231	3.454
4340	16.156109	0.71199516	0.5390652	3.440
4360	16.040147	0.70688475	0.5422841	3.426
4380	15.924542	0.70179005	0.5454799	3.412
4400	15.809312	0.69671189	0.5486526	3.399
4420	15.694475	0.69165105	0.5518022	3.385
4440	15.580048	0.68660828	0.5549290	3.372
4460	15.466047	0.68158430	0.5580329	3.359
4480	15.352488	0.67657979	0.5611141	3.346
4500	15.239386	0.67159541	0.5641726	3.333
4520	15.126754	0.66663178	0.5672085	3.320
4540	15.014607	0.66168948	0.5702220	3.308
4560	14.902957	0.65676909	0.5732130	3.295
4580	14.791816	0.65187113	0.5761819	3.283
4600	14.681195	0.64699612	0.5791285	3.271
4620	14.571106	0.64214453	0.5820531	3.259
4640	14.461560	0.63731683	0.5849557	3.247
4660	14.352564	0.63251344	0.5878364	3.235
4680	14.244130	0.62773478	0.5906955	3.223
4700	14.136266	0.62298122	0.5935329	3.211
4720	14.028979	0.61825313	0.5963488	3.200
4740	13.922278	0.61355085	0.5991433	3.188
4760	13.816170	0.60887470	0.6019165	3.177
4780	13.710662	0.60422498	0.6046684	3.166
4800	13.605760	0.59960197	0.6073995	3.155
4820	13.501469	0.59500593	0.6101096	3.144
4840	13.397797	0.59043711	0.6127989	3.133
4860	13.294747	0.58589572	0.6154676	3.122
4880	13.192324	0.58138199	0.6181157	3.111
4900	13.090533	0.57689609	0.6207434	3.101
4920	12.989378	0.57243822	0.6233509	3.090
4940	12.888863	0.56800852	0.6259381	3.080
4960	12.788990	0.56360715	0.6285053	3.069
4980	12.689763	0.55923424	0.6310526	3.059

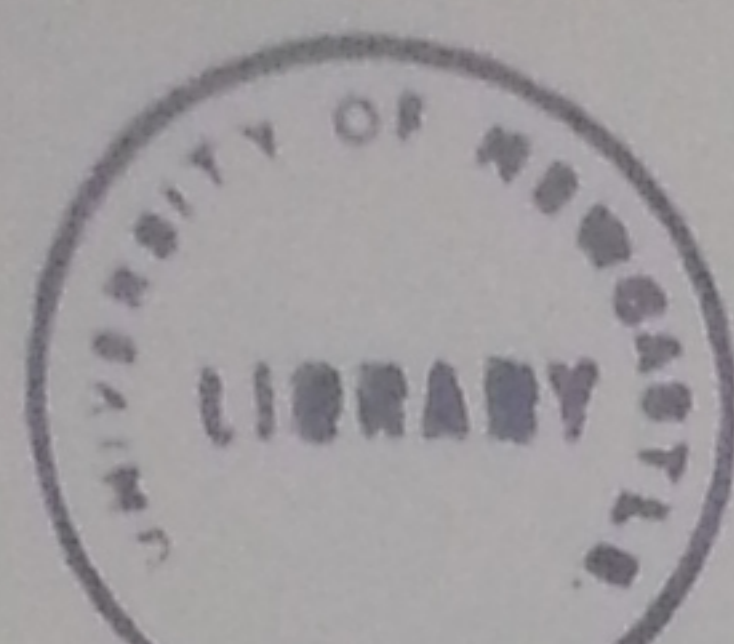
NLAMB DAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
5000	12.591184	0.55488990	0.6335802	3.049
5020	12.493256	0.55057425	0.6360881	3.039
5040	12.395981	0.54628737	0.6385764	3.029
5060	12.299361	0.54202934	0.6410454	3.019
5080	12.203397	0.53780023	0.6434952	3.009
5100	12.108090	0.53360011	0.6459258	2.999
5120	12.013442	0.52942901	0.6483374	2.990
5140	11.919454	0.52528697	0.6507301	2.980
5160	11.826126	0.52117402	0.6531042	2.971
5180	11.733458	0.51709017	0.6554596	2.961
5200	11.641451	0.51303543	0.6577965	2.952
5220	11.550104	0.50900980	0.6601152	2.943
5240	11.459417	0.50501326	0.6624156	2.934
5260	11.369390	0.50104580	0.6646980	2.925
5280	11.280022	0.49710739	0.6669624	2.916
5300	11.191313	0.49319798	0.6692090	2.907
5320	11.103261	0.48931755	0.6714380	2.898
5340	11.015865	0.48546604	0.6736494	2.889
5360	10.929124	0.48164339	0.6758434	2.881
5380	10.843036	0.47784954	0.6780201	2.872
5400	10.757601	0.47408442	0.6801796	2.864
5420	10.672815	0.47034796	0.6823222	2.855
5440	10.588679	0.46664007	0.6844478	2.847
5460	10.505188	0.46296067	0.6865567	2.838
5480	10.422342	0.45930967	0.6886490	2.830
5500	10.340138	0.45568698	0.6907248	2.822
5520	10.258575	0.45209248	0.6927842	2.814
5540	10.177648	0.44852607	0.6948273	2.806
5560	10.097357	0.44498766	0.6968544	2.798
5580	10.017698	0.44147711	0.6988654	2.790
5600	9.938669	0.43799432	0.7008606	2.782
5620	9.860266	0.43453915	0.7028400	2.774
5640	9.782488	0.43111150	0.7048039	2.767
5660	9.705332	0.42771122	0.7067522	2.759
5680	9.628793	0.42433819	0.7086852	2.751
5700	9.552870	0.42099227	0.7106029	2.744
5720	9.477559	0.41767333	0.7125055	2.736
5740	9.402856	0.41438122	0.7143931	2.729
5760	9.328760	0.411111580	0.7162659	2.721
5780	9.255266	0.40787694	0.7181239	2.714
5800	9.182370	0.40466447	0.7199672	2.707
5820	9.110071	0.40147825	0.7217960	2.700
5840	9.038364	0.39831813	0.7236105	2.693
5860	8.967245	0.39518396	0.7254106	2.685
5880	8.896712	0.39207558	0.7271966	2.678
5900	8.826760	0.38899284	0.7289686	2.671
5920	8.757387	0.38593557	0.7307266	2.665
5940	8.688588	0.38290362	0.7324708	2.658
5960	8.620360	0.37989683	0.7342013	2.651
5980	8.552699	0.37691504	0.7359182	2.644

NLAMBDA MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
6000	8.485602	0.37395808	0.7376216	2.637
6050	8.320299	0.36667324	0.7418220	2.621
6100	8.158437	0.35954000	0.7459407	2.605
6150	7.999955	0.35255576	0.7499792	2.589
6200	7.844794	0.34571787	0.7539394	2.573
6250	7.692895	0.33902371	0.7578229	2.558
6300	7.544197	0.33247063	0.7616311	2.543
6350	7.398640	0.32605599	0.7653659	2.528
6400	7.256165	0.31977713	0.7690287	2.513
6450	7.116711	0.31363144	0.7726210	2.499
6500	6.980219	0.30761629	0.7761443	2.485
6550	6.846631	0.30172909	0.7796001	2.471
6600	6.715887	0.29596726	0.7829899	2.457
6650	6.587930	0.29032823	0.7863150	2.444
6700	6.462703	0.28480949	0.7895768	2.431
6750	6.340148	0.27940852	0.7927767	2.418
6800	6.220209	0.27412287	0.7959160	2.405
6850	6.102832	0.26895009	0.7989960	2.393
6900	5.987961	0.26388777	0.8020179	2.381
6950	5.875544	0.25893355	0.8049831	2.369
7000	5.765526	0.25408510	0.8078926	2.357
7050	5.657856	0.24934011	0.8107477	2.345
7100	5.552482	0.24469634	0.8135496	2.334
7150	5.449355	0.24015155	0.8162993	2.322
7200	5.348425	0.23570357	0.8189981	2.311
7250	5.249642	0.23135025	0.8216470	2.300
7300	5.152960	0.22708951	0.8242470	2.290
7350	5.058332	0.22291926	0.8267991	2.279
7400	4.965711	0.21883749	0.8293045	2.269
7450	4.875053	0.21484222	0.8317641	2.258
7500	4.786314	0.21093150	0.8341788	2.248
7550	4.699450	0.20710343	0.8365497	2.238
7600	4.614419	0.20335614	0.8388776	2.228
7650	4.531179	0.19968780	0.8411634	2.219
7700	4.449691	0.19609664	0.8434080	2.209
7750	4.369914	0.19258089	0.8456124	2.200
7800	4.291810	0.18913885	0.8477773	2.191
7850	4.215340	0.18576884	0.8499033	2.181
7900	4.140467	0.18246922	0.8519918	2.172
7950	4.067155	0.17923839	0.8540431	2.164

NLAMBDA MICRON	DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
8000		3.995369	0.17607478	0.8560583	2.155
8050		3.925073	0.17297687	0.8580379	2.146
8100		3.856234	0.16994315	0.8599827	2.138
8150		3.788818	0.16697217	0.8618935	2.129
8200		3.722794	0.16406249	0.8637709	2.121
8250		3.658129	0.16121271	0.8656157	2.113
8300		3.594792	0.15842148	0.8674285	2.105
8350		3.532754	0.15568746	0.8692099	2.097
8400		3.471984	0.15300935	0.8709606	2.089
8450		3.412454	0.15038587	0.8726813	2.082
8500		3.354135	0.14781579	0.8743725	2.074
8550		3.297001	0.14529790	0.8760349	2.067
8600		3.241023	0.14283099	0.8776690	2.059
8650		3.186177	0.14041394	0.8792754	2.052
8700		3.132436	0.13804560	0.8808547	2.045
8750		3.079776	0.13572486	0.8824073	2.038
8800		3.028171	0.13345067	0.8839339	2.031
8850		2.977599	0.13122196	0.8854350	2.024
8900		2.928036	0.12903772	0.8869110	2.017
8950		2.879458	0.12689693	0.8883626	2.010
9000		2.831845	0.12479863	0.8897900	2.003
9050		2.785174	0.12274186	0.8911939	1.997
9100		2.739425	0.12072569	0.8925747	1.990
9150		2.694576	0.11874922	0.8939329	1.984
9200		2.650608	0.11681155	0.8952689	1.978
9250		2.607500	0.11491182	0.8965831	1.971
9300		2.565235	0.11304918	0.8978759	1.965
9350		2.523792	0.11122282	0.8991479	1.959
9400		2.483155	0.10943193	0.9003993	1.953
9450		2.443304	0.10767572	0.9016306	1.947
9500		2.404223	0.10595343	0.9028422	1.941
9550		2.365894	0.10426430	0.9040344	1.935
9600		2.328302	0.10260762	0.9052077	1.930
9650		2.291429	0.10098266	0.9063623	1.924
9700		2.255261	0.09938873	0.9074987	1.918
9750		2.219781	0.09782515	0.9086172	1.913
9800		2.184975	0.09629126	0.9097181	1.907
9850		2.150828	0.09478642	0.9108018	1.902
9900		2.117326	0.09333099	0.9118686	1.896
9950		2.084455	0.09186134	0.9129188	1.891

NLAMBDAT MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
10000	2.052200	0.09043990	0.9139527	1.886
10100	1.989490	0.08767626	0.9159729	1.876
10200	1.929091	0.08501452	0.9179315	1.865
10300	1.870907	0.08245037	0.9198309	1.856
10400	1.814844	0.07997970	0.9216732	1.846
10500	1.760813	0.07759856	0.9234605	1.837
10600	1.708729	0.07530323	0.9251947	1.827
10700	1.658511	0.07309013	0.9268778	1.818
10800	1.610082	0.07095586	0.9285116	1.809
10900	1.563367	0.06889717	0.9300978	1.801
11000	1.518298	0.06691096	0.9316382	1.792
11100	1.474805	0.06499427	0.9331343	1.784
11200	1.432827	0.06314429	0.9345877	1.776
11300	1.392301	0.06135832	0.9359998	1.768
11400	1.353169	0.05963378	0.9373721	1.760
11500	1.315375	0.05796822	0.9387060	1.752
11600	1.278866	0.05635929	0.9400027	1.745
11700	1.243592	0.05480476	0.9412636	1.737
11800	1.209503	0.05330248	0.9424897	1.730
11900	1.176554	0.05185040	0.9436824	1.723
12000	1.144699	0.05044657	0.9448437	1.716
12100	1.113896	0.04908911	0.9459726	1.709
12200	1.084106	0.04777625	0.9470712	1.703
12300	1.055288	0.04650627	0.9481405	1.696
12400	1.027406	0.04527752	0.9491815	1.689
12500	1.000425	0.04408845	0.9501944	1.683
12600	0.974310	0.04293756	0.9511815	1.677
12700	0.949028	0.04182342	0.9521428	1.671
12800	0.924549	0.04074464	0.9530794	1.665
12900	0.900843	0.03969992	0.9539918	1.659
13000	0.8777881	0.03868799	0.9548809	1.653
13100	0.855636	0.03770765	0.9557474	1.647
13200	0.834081	0.03675773	0.9565920	1.642
13300	0.813192	0.03583715	0.9574154	1.636
13400	0.792944	0.03494482	0.9582183	1.631
13500	0.773314	0.03407974	0.9590012	1.625
13600	0.754280	0.03324092	0.9597647	1.620
13700	0.735821	0.03242743	0.9605096	1.615
13800	0.717916	0.03163836	0.9612362	1.610
13900	0.700546	0.03087287	0.9619453	1.605
14000	0.683692	0.03013011	0.9626372	1.600
14100	0.667335	0.02940930	0.9633125	1.595
14200	0.651460	0.02870967	0.9639717	1.590
14300	0.636048	0.02803049	0.9646153	1.586
14400	0.621085	0.02737105	0.9652437	1.581
14500	0.606554	0.02673068	0.9658574	1.576
14600	0.592441	0.02610873	0.9664567	1.572
14700	0.578732	0.02550458	0.9670421	1.568
14800	0.565413	0.02491762	0.9676140	1.563
14900	0.552471	0.02434727	0.9681728	1.559

NLAMBDA MICRON DEG.K	MONOCHROMATIC EMISSIVE POWER x 10 ⁵	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
15000	0.539894	0.02379300	0.9687189	1.555
15100	0.527669	0.02325425	0.9692525	1.551
15200	0.515785	0.02273051	0.9697741	1.546
15300	0.504230	0.02222130	0.9702840	1.542
15400	0.492994	0.02172613	0.9707824	1.538
15500	0.482067	0.02124456	0.9712698	1.534
15600	0.471437	0.02077613	0.9717465	1.531
15700	0.461097	0.02032043	0.9722126	1.527
15800	0.451036	0.01987704	0.9726685	1.523
15900	0.441245	0.01944558	0.9731146	1.519
16000	0.431717	0.01902566	0.9735509	1.516
16100	0.422442	0.01861692	0.9739779	1.512
16200	0.413413	0.01821901	0.9743957	1.509
16300	0.404622	0.01783158	0.9748046	1.505
16400	0.396061	0.01745432	0.9752049	1.502
16500	0.387724	0.01708690	0.9755967	1.498
16600	0.379603	0.01672902	0.9759802	1.495
16700	0.371692	0.01638039	0.9763558	1.491
16800	0.363985	0.01604073	0.9767235	1.488
16900	0.356475	0.01570976	0.9770837	1.485
17000	0.349156	0.01538722	0.9774364	1.482
17100	0.342023	0.01507286	0.9777819	1.479
17200	0.335069	0.01476643	0.9781204	1.475
17300	0.328290	0.01446768	0.9784520	1.472
17400	0.321681	0.01417641	0.9787769	1.469
17500	0.315236	0.01389237	0.9790952	1.466
17600	0.308950	0.01361537	0.9794073	1.463
17700	0.302820	0.01334519	0.9797131	1.460
17800	0.296839	0.01308163	0.9800128	1.458
17900	0.291005	0.01282451	0.9803067	1.455
18000	0.285312	0.01257363	0.9805948	1.452
18100	0.279757	0.01232882	0.9808772	1.449
18200	0.274335	0.01208990	0.9811542	1.446
18300	0.269044	0.01185670	0.9814258	1.444
18400	0.263878	0.01162907	0.9816922	1.441
18500	0.258836	0.01140683	0.9819535	1.438
18600	0.253912	0.01118985	0.9822099	1.436
18700	0.249104	0.01097798	0.9824613	1.433
18800	0.244409	0.01077107	0.9827080	1.431
18900	0.239824	0.01056898	0.9829501	1.428
19000	0.235344	0.01037158	0.9831876	1.426
19100	0.230969	0.01017874	0.9834207	1.423
19200	0.226694	0.00999034	0.9836495	1.421
19300	0.222516	0.00980625	0.9838740	1.418
19400	0.218435	0.00962636	0.9840945	1.416
19500	0.214445	0.00945056	0.9843109	1.413
19600	0.210546	0.00927873	0.9845233	1.411
19700	0.206735	0.00911077	0.9847319	1.409
19800	0.203009	0.00894657	0.9849364	1.407
19900	0.199366	0.00878603	0.9851376	1.404



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WAVELENGTH MICRON	TEMPERATURE DEG.K	MONOCHROMATIC EMISSIVE POWER $\times 10^5$	RATIO OF ENERGY TO MAX 2897.796	FRACTIONAL BLACK EMISSION	AUXILIARY ERROR FUNCTION
20000		0.195804	0.00862906	0.9853351	1.402
20200		0.188915	0.00832545	0.9857197	1.398
20400		0.182325	0.00803501	0.9860908	1.393
20600		0.176018	0.00775707	0.9864490	1.389
20800		0.169980	0.00749099	0.9867949	1.385
21000		0.164198	0.00723617	0.9871290	1.381
21200		0.158658	0.00699205	0.9874517	1.377
21400		0.153350	0.00675809	0.9877636	1.373
21600		0.148260	0.00653379	0.9880651	1.369
21800		0.143379	0.00631869	0.9883567	1.366
22000		0.138696	0.00611233	0.9886386	1.362
22200		0.134203	0.00591429	0.9889115	1.358
22400		0.129889	0.00572418	0.9891761	1.355
22600		0.125746	0.00554162	0.9894317	1.351
22800		0.121767	0.00536625	0.9896792	1.348
23000		0.117943	0.00519774	0.9899188	1.345
23200		0.114268	0.00503577	0.9901510	1.342
23400		0.110734	0.00488004	0.9903759	1.338
23600		0.107335	0.00473026	0.9905940	1.335
23800		0.104066	0.00458616	0.9908053	1.332
24000		0.100919	0.00444749	0.9910103	1.329
24200		0.097890	0.00431401	0.9912090	1.326
24400		0.094974	0.00418548	0.9914018	1.323
24600		0.092165	0.00406168	0.9915889	1.320
24800		0.089458	0.00394242	0.9917705	1.318
25000		0.086850	0.00382749	0.9919467	1.315
25200		0.084337	0.00371670	0.9921170	1.312
25400		0.081913	0.00360989	0.9922832	1.309
25600		0.079575	0.00350687	0.9924446	1.307
25800		0.077320	0.00340749	0.9926015	1.304
26000		0.075144	0.00331159	0.9927539	1.302
26200		0.073044	0.00321904	0.9929020	1.299
26400		0.071016	0.00312969	0.9930460	1.297
26600		0.069059	0.00304341	0.9931861	1.294
26800		0.067168	0.00296007	0.9933223	1.292
27000		0.065341	0.00287956	0.9934547	1.290
27200		0.063575	0.00280177	0.9935836	1.287
27400		0.061869	0.00272657	0.9937090	1.285
27600		0.060220	0.00265388	0.9938311	1.283
27800		0.058625	0.00258358	0.9939499	1.281
28000		0.057082	0.00251560	0.9940656	1.278
28200		0.055589	0.00244983	0.9941782	1.276
28400		0.054145	0.00238619	0.9942879	1.274
28600		0.052748	0.00232459	0.9943948	1.272
28800		0.051395	0.00226497	0.9944989	1.270
29000		0.050085	0.00220725	0.9946003	1.268
29200		0.048816	0.00215135	0.9946992	1.266
29400		0.047588	0.00209720	0.9947956	1.264
29600		0.046397	0.00204474	0.9948895	1.262
29800		0.045244	0.00199391	0.9949811	1.260
30000		0.044126	0.00194464	0.9950705	1.258



